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## Increasing the Dynamic of Spectrum Access

By Thomas Kidd - July-September 2012

The final step in the dynamic federal agency spectrum access process within the United States is receiving a radio frequency assignment from the National Telecommunications and Information Administration. This notification from the assistant secretary of commerce for communications and information is required for federal spectrum-dependent systems to operate within the United States. The Code of Federal Regulations Title 47 Part 300, also known as the "Manual of Regulations and Procedures for Federal Radio Frequency Management," establishes this requirement for all spectrum-dependent systems operated by the federal government.

In addition to federal regulatory compliance, a radio frequency assignment also provides operational value to federal agencies. A radio frequency assignment protects a stakeholder's rights to operate in the electromagnetic environment with an assurance of protection from harmful interference by other spectrum-dependent systems. Through the radio frequency assignment coordination and approval process, a spectrum stakeholder also assures other federal, non-federal and commercial systems similar protection from harmful interference by a new system. The radio frequency assignment process is a principal tenet of sharing spectrum access.

Another important value provided by a radio frequency assignment is a record of spectrum use. Radio frequency assignment requirements and data provide key metrics for equipment installation, acquisition, research and development. Interconnections among spectrum-dependent system databases and the government master file of radio frequency assignments enable federal agencies to accurately assess current and future spectrum needs. Centralized databases provide foundational information of how federal, non-federal and commercial stakeholders use their assigned spectrum in the electromagnetic environment.

Through the application for radio frequency assignment, federal agencies continually demonstrate their requirement for spectrum-dependent operations and access to the electromagnetic environment. Balancing federal, state and local government access in the electromagnetic environment with commercial demand and revenue potential requires high fidelity data provided by radio frequency assignment records.

Acquiring a radio frequency assignment is an iterative process with periodic reassessment of spectrum requirements to incorporate changes in the electromagnetic environment. As a result of these ongoing processes, radio frequency assignment databases represent the dynamic electromagnetic environment in continual transformation. The cycle time to obtain a radio frequency assignment is typically 100 days. However, the convergence of software defined radios, cognitive radio systems and the increasing burden of operating in congested electromagnetic environments are challenging spectrum managers to reduce radio frequency assignment cycle times from 100 days to less than one second.

The radio frequency assignment business process has been greatly enhanced through automation. However, the current radio frequency assignment business process remains both manual and people centric. Machines provide tools for people to make decisions, but very few decisions are automated. Computer networks enable collaboration. Spectrum management professionals use engineering and business process tools to assist whenever possible. However, electromagnetic spectrum management remains dependent on people. Final decisions management remains dependent on people. Final decisions are reached by consensus among highly skilled professionals representing myriad stakeholders. The cumulative effects result in a dynamic process unable to meet the rapid reconfiguration requirements of emerging technology.

Traditional process improvement techniques are not designed to produce savings at the orders of magnitude needed to transform the radio frequency assignment process. Transforming the radio frequency assignment process from 100 days to less than one second requires several ambitious and transformational phases. Each phase will reinvent the radio frequency assignment business process while retaining the core values of preventing harmful interference, recording spectrum use and assuring regulatory compliance. Phase one will reduce radio frequency assignment processing time from 100 days to one day; phase two will reduce the time from one day to one minute; and phase three will reduce the time from one minute to less than one second. These phases roughly coincide with two or three orders of magnitude process improvements.

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The first phase in transforming the radio frequency assignment business process, reducing cycle time from 100 days to one day, will be accomplished through automated decisions. Algorithms will be implemented into central processing systems to enable interference analysis and operational coordination via a machine-to-machine interface. Decisions will be made by approved algorithms with exceptions approved by stakeholder validation. Access will be available to central processing systems via user interfaces available and understandable to equipment operators, installers and maintainers. Regulatory compliance is assured by proxy through recognition that consensus among stakeholders provides sufficient oversight to authorize frequency use. Spectrum use will be recorded in a similar way to legacy business processes.

As a result of the first phase business transformation, the radio frequency assignment process will be accomplished with machine-to-machine communications; people will only engage to manage exceptions to the process. People will make decisions only when machine algorithms cannot. Beginning this process improvement before the end of 2013 will enable the next phase to begin by 2016.

The second phase scenario of transformation improves the radio frequency assignment business process from one day to approximately one minute. Protection from harmful interference is assured by stakeholders' algorithms implemented in local autonomous decision engines. Interactions are machine-to-machine. Radio frequency assignment decisions in the second phase will be made by spectrum-dependent systems interacting with radio frequency assignment decision engines residing in a cloud environment.

Universally accepted decision-making algorithms accessible in the cloud will make all decisions. Systems will get information into and out of the cloud with limited or no human assistance. All processes will be autonomous and decisions will no longer require people to intervene. The radio frequency assignment business process will reside on the Internet, in local machines and on spectrum-dependent devices. Spectrum use will be recorded in central repositories and regulatory compliance is assured through designation of standardized decision algorithms. This phase must begin in early 2017 and be completed within 48 months to ensure the final phase begins at the end of 2020.

The envisioned final phase of radio frequency assignment business transformation to improve the business process from one minute to less than one second will move the process onto the spectrum-dependent device. Systems will autonomously consider electromagnetic environmental knowledge and regulatory requirements to determine appropriate behavior. These spectrum-dependent systems will operate autonomously and ubiquitously from the current people-centric manual radio frequency assignment process. The radio frequency assignments made within these devices will have comparable authorities to operate and rights to interference protection as current radio frequency assignments. If phases one and two occur at roughly four-year intervals, the final phase of transformation could be in place by the end of 2024.

Technological advancements timelines and business processes improvement cycles do not occur simultaneously. Implementation of business process transformation improvements must accommodate fiscal year cycles and budgeting constraints, as well as cultural shifts and human resources concerns. Yet enabling dynamic access of the electromagnetic spectrum, while maintaining full value to the operator, must be accomplished. Initiating these improvements now, and maintaining a commitment to business transformation, will be critical to enable spectrum management processes and technological advances to coincide before 2025.

*Thomas Kidd is the lead for strategic spectrum policy for the Department of the Navy.*

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